Simulating a Post-Fordist urban system: preliminary results from the PF.US model

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ABSTRACT

In a previous paper we argued that some major novelties to be addressed by a new generation of urban models are related to: i) the knowledge expectations connected with the use of a model (i.e. epistemological background), ii) the feasibility of its application domain (i.e. the operational underpinnings) and iii) the urban phenomena and perceptions characterising modern cities (i.e. the so-called urban Post-Fordist developmental processes).

We also emphasised that many drawbacks and limitations which nowadays make the classical urban modelling unsatisfactory were not caused so much by their methodological underpinnings but rather by the limited scope of the whole model application.

This paper presents an urban operational simulation model (the so called Post Fordist Urban Simulation model) which broadens the focus of the classical model application and allows to explore some features of the new kind of development taking place in modern cities (i.e. the local-global interactions, the role of localised resources).

The paper is articulated into three parts. Part 1 reviews some major trends of changes which are taking place in the urban modelling field. Part 2 outlines the conceptual structure and main novelties of the PF.US the model. Part 3 presents the preliminary results of its application to the Piedmont region.

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1. Introduction

New potentialities exist for operational urban modelling. The issues have already been taken up in a number of papers recently appeared in the literature (i.e. Batty, 1994, Harris, 1994, Wegener, 1994). One major claim in the ongoing debate is that many drawbacks which nowadays make the classical urban modelling unsatisfactory are caused by the narrow scope of the whole model application (Rabino and Occelli, 1997).

This paper presents an operational simulation model (the so called Post Fordist Urban Simulation model) which broadens the focus of usual model applications. Its aims are twofold: a) to explore some features of the new kind of development taking place in modern cities ,i.e. the local-global interactions and the role of localised resources as factors of development; b) to show the intrinsic value of modelling as a learning tool.

The paper is articulated into three parts. Part 1 reviews some major trends of changes which are taking place in the urban modelling field. These provide the background for developing the PF.US model. Part 2 outlines the conceptual structure and main novelties of the PF.US model. Lastly, part 3 presents the preliminary results of its application to the Piedmont region. Some comments about the experience carried out so far conclude the paper.

2. The background of the PF.US model

Urban modelling, whether related to all the main urban sub-systems (population, economic activity, housing and transportation) or only some of them, has a well-established tradition in geography, although its alternate fortune. Since its early development in land-use and transportation planning in the fifties substantial advancements have been made. After the sharp criticisms of the seventies (see Lee, 1973) a deep ‘restructuring’ swept over the field, shaking both the conceptual and methodological underpinnings (Batty, 1979, Klostermann, 1994). At present, in the mid-nineties, a revival of interest is peeping out and new modelling possibilities are opening up (see also Harris, 1994, Wegener, 1994).

Here we would like to emphasise a few aspects of these possibilities as they set up the premises for building a new generation of operational urban models. They also constitute the basis for developing what we call the *Post Fordist Urban Simulation (*PF.US) model. These stem from several changes which have taken place in the urban modelling field over the past twenty years and concern the epistemological and operational backgrounds and socio-cultural context.

a.The epistemological background

A first source of changes in model building, which is also investing the whole field of quantitative geography, stems from the epistemological context (see Rabino, 1995, Maestre, 1994). This is reflected in the evolution of the concept of model as embedded in the several notions which have been proposed over the years:

a. an earlier definition argued that ‘a model can be a theory or a law or an hypothesis or a structured idea. It can be a role, a relation or an equation. It can be synthesis of data. Most important from the geographical viewpoint, it can also include reasoning about the real world by means of translations in space or time’ (Hagget and Chorley, 1967);

b. a later definition emphasised that ‘a model is an experimental project based on a theory. Its realisation requires a formalising process which is based on the scientific method and whose main steps are: hypothesis formulation, observation, data collection, model development and implementation, testing, validation and forecasting’ (Batty, 1976);

c. a more recent definition states that ‘a model is any tool or mechanism which allows forecasting. More precisely, the tool or mechanism must be based on a theory and forecasting must be testable. Modelling is then an activity which allows theory to be analysed critically and models are not representations of reality but representations of our knowledge about reality’ (Haines - Young, 1988).

Although sharing a common understanding about the basic concept of modelling, these definitions reveal some differences as far as the application of the concept is concerned. The shared notion is the well-known one according to which a model is considered as a process by which an understanding of a phenomenon in the real world is gained (Batty, 1978). The notions of theory and model, then, are to be considered as interdependent and complementary. The main differences are in the emphasis given to both the meaning and role of the 'description' derived from modelling (i.e. what in Fig.1 has been called ‘internal reality’). In this respect, two interpretations have been provided (see also Giaccaria, 1996):

1) according to the first, which we can name ‘structuralist’, modelling is an activity by which an understanding of the organisational structure of an urban system is obtained. Modelling, i.e. a mathematical computer model, allows to identify the relevant components and relationships of the system as well as some significant features of its behaviour. Through it a ‘representation’ although simplified and partial of both urban phenomena and their likely reactions to the impact of external actions can be obtained. This interpretation, which is rooted in the General System Theory, is at the basis of the first two notions of model, although the second, alluding to the

various stages of the modelling process (Casti, 1984) can also be a reference for the planning cycle;

2) according to the second interpretation,which we can name ‘cognitivist’, modelling offers a mean for testing the modeller’s knowledge about certain urban phenomena. The model, i.e. which, is still a computer model, makes it possible to obtain deeper insights or suggest new clues for revising or modifying the original hypotheses. Model outputs are representations of the ‘visions’, resulting from the working of the hypotheses embedded in the model. This interpretation is clearly reflected in the third of the model concepts mentioned above.

These interpretations reflect the two ‘souls’ of urban modelling and are intrinsically tied together although not coincident. Whereas the ‘structuralist’ has been central in the first generation of models, nowadays it appears to have lost its relevance, and this independently from the sharp criticisms which were made to the earlier models (Lee, 1973). What has been progressively fading, above all during the eighties, is the original scope of urban models,i.e. their technical and procedural motivations in relation to the comprehensive planning process and rational decision-making. Nonetheless, the soul of the structuralist interpretation is still well alive, although in different but related domains of quantitative geography (i.e. GIS, DSS, NN).

The acknowledgement of the limits of rationality and needs to develop a new philosophy for social action (Batty, 1978), has certainly contributed to foster an interest in the ‘cognitivist’ interpretation. In this respect, the recent debate on the role of science has provided a wider framework, and the relativism of the ‘visions’ of spatial realities are addressed by several approaches (i.e. hermeneutic, deconstructionism, etc.) (Rabino, 1995). Two related aspects to the cognitivist interpretation concern:

a) the awareness that modelling is an activity which is worthwhile by its own; to engage in urban and spatial modelling is useful because through the process deeper insights are gained and ‘new knowledge’ is created, also independently from the drives of planning. Modelling can help in identifying and targeting future or existing but ill-defined urban problems (i.e. a shift from the problem solving to the problem definition approach);

b) the introduction of new model paradigms in which randomness and unpredictability are essential features. Here the traditional juxtapositions between prediction and prescription, the positive and the normative, science and design become blurred and meaningless. Modelling provides a consistent framework according to which either systematically exploring a wide range of urban morphologies either deriving a set of ‘representations’

Whereas differences between the 'structuralist' and 'cognitivist' interpretation are becoming more clearly noticeable, the complementarities of their roles in dealing with urban phenomena are also becoming more evident. If for complex systems such as cities, 'the multiplicity of disciplinary viewpoints and paradigms is the norm' (Batty and Xie, 1996), then one major challenge for urban modelling is how to reconcile the connections between the two interpretations. In this direction, some possibilities are in:

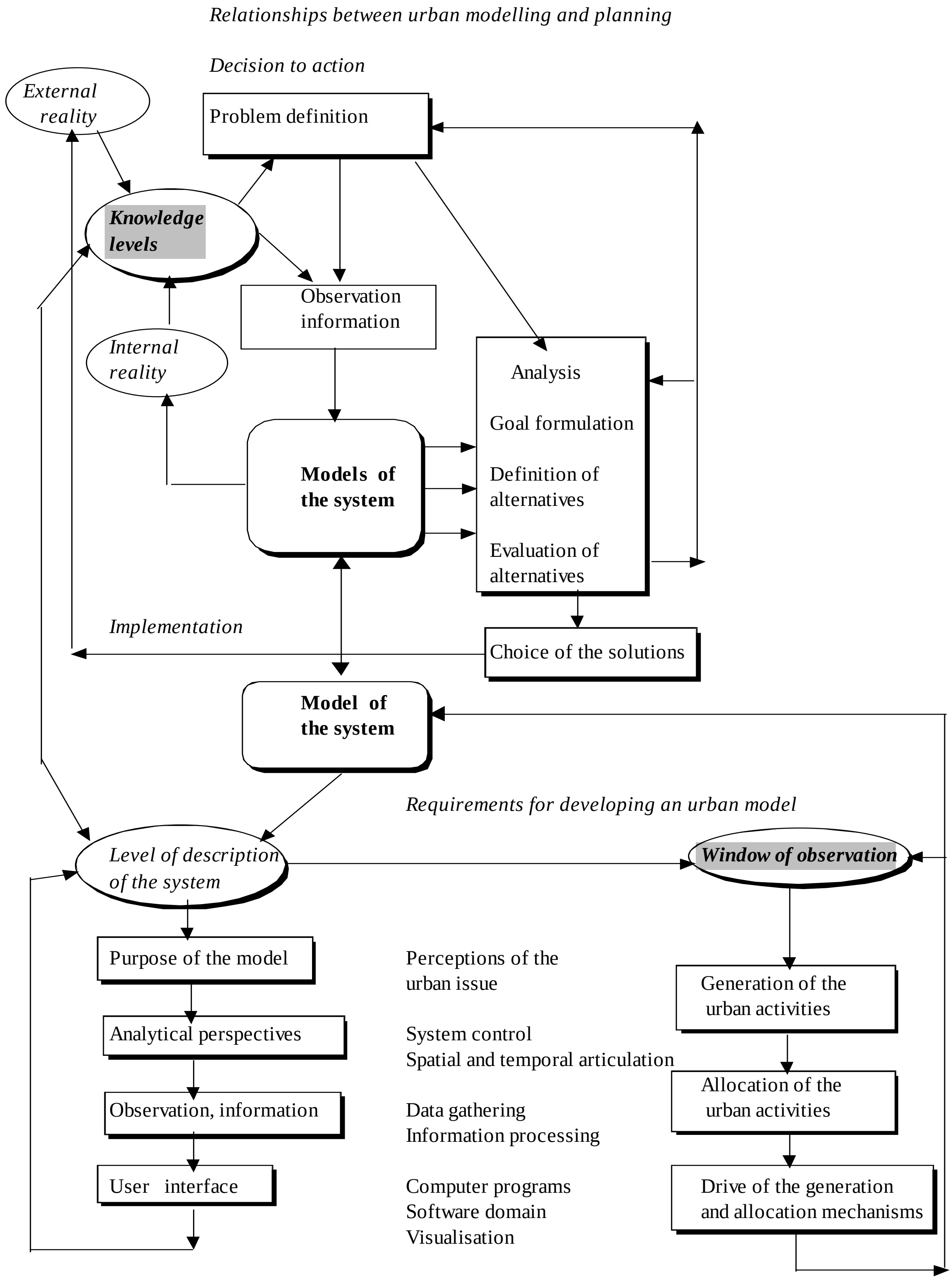
a) the 'identification and judicious description of relatively invariant factors that can be expected to constrain the observable system states ' (i.e. those features which make up the historical and structural prior information for a certain system, Couclelis, 1984) ;
b) the possibility, which also results particularly useful from an operational point of view, to define a number of 'windows of observation' through which certain system features and properties can be described (Rabino, 1996;see also Fig.1);
c) the reference to a concept of 'virtual system organisation' which can enhance our prescriptive capacity in addressing urban problems (Turoff, 1997).

b. The operational background

The extent to which urban models could be operationalized and applied to real situation, played a significant role in their development. The progress in information technologies and the increasing power in desk-top computing have been crucial since the early phase of urban modelling. Notwithstanding a number of conceptual as well as methodological questions still remain to be solved (see, for example, Anselin and Madden, eds., 1990), considerable advances have been made and these are detailed in the proliferous literature of the last decade (see Nijkamp and Rietveld,1984, Hunt and Simmonds, 1993, Batty, 1994, 1995).

Besides making it possible to link more efficiently some basic ingredients of urban models with other methodologies of spatial analysis, i.e. the connections between spatial data, indicators and graphical representations (visual images), a new technological 'backcloth' is being made available (Occelli, 1995). This opens new ways for broadening the scope of model application, even beyond the one which sees a model as a 'core-component' of an integrated socio-geographical information system (Geenhuizen and Nijkamp, 1995). Although still difficult to grasp, some consequences of the new technological 'backcloth' can be indicated in the following:

a. the first and perhaps most relevant consequence is associated with the changing role of computers in model application. Until few years ago, computers were tools which made experimentation possible. Their technological sophistication set a benchmark to the degree of model operationalisation. At present, computers are an essential component of the modelling activity (see the role of the ‘genetic algorithms’ in the application of the game of life);



b

Figure 1 A framework for developing an operational urban model

c. the second consequence concerns the increased efficiency in model use. Because of technological improvements, models can now be applied at kind of problems which could not have been tackled earlier or could at prohibitive costs. In addition, by making possible alternative means of implementation (i.e. parallel computing, computer vision) an evolution of existing modelling approaches is also occurring (i.e. the application of computer vision in multivariate analysis);
d. a final consequence deals with the enhancement of communication possibilities. New information technologies foster the diffusion of computing potentialities among a wider and more diversified public. Besides helping to overcome that kind of ‘antiscientific’ attitude pointed out by some authors some time ago (Batty, 1978), the possibility of running models ‘locally’ broadens the scope of model application (i.e. allowing to share the experience carried out elsewhere and perform one's own experiments). Models, therefore, offer essential supports in learning about ‘how to learn about’ urban processes.

c. The socio-cultural context.

A final source of changes in model building relates to the social and cultural milieu within which modelling activity occurs. As the cultural and information levels of society as a whole are raising, the socio-cultural context is becoming more demanding and selective in terms of the expected kind of knowledge (Rabino, 1995, Knight, 1995).

Firstly, the awareness of the multiplicity of processes which combine to produce the overall changes in urban systems is increasing. The conceptual unity of the urban system, given by the interacting components of an urban economy, is not considered any longer as an axiomatic entity. Rather, it results from a permanent re-definition in which great emphasis is given to the interplay of the actions (behaviour) of a variety of actors, whose effects unfold on different spatial and temporal scales and, given the set of system constraints, determine a range of viable paths of urban evolution. The increasing diversification of urban phenomena is also acknowledged on a phenomenological ground. In the ongoing debate about the transition to a post-industrial society, several processes, i.e. ‘urban sustainability’, decentralisation of government, globalisation of economy and the impact of the new information technologies, have been recognised to have an influence on the emerging urban issues. Whereas urban systems are being perceived as multi-faceted, locally diversified and subjected to the strain of the local-global tensions, also the traditional planning questions are put in a new light: besides the necessity to disentangle the relevant questions to be answered by policies, new needs are emerging for devising proactive policies aiming at anticipating problems (i.e. those concerning the benefits and equity of the developmental issues).

Given the above changes a different way to conceive the relationships between the observer (the modeller) and reality (the modelled system) should not come unexpected (Maestre, 1994). Not only the acknowledgement that the observer is part of the observed reality, makes himself a subject of urban change as any other agents, but also his role as a 'maven' does not hold any more. On the one hand, the observer is an analyst whose main task is to arrive at a solution (i.e. a range of alternative solutions) to a given problem. As a problem-solver, then, his specific role, does not differ from that of any other urban analysts or practitioners. On the other hand, through the modelling activity, the observer can set up an intelligent interface able to favour the communication process of the various system descriptions. A major issue in this respect, concerns the realisation and outcome of the 'learning process' which can be activated by such communication process.

3. The PF.US model : from conception to implementation

3.1 A Fordist urban model

A cornerstone in urban modelling is the Lowry model (Lowry, 1964). Even the most recent approaches which integrate land-uses and transportation are still based on the urban accounting framework of this model (Wegener, 1994). The fortune of the Lowry model derives from a fruitful merging of certain methodological and substantial hypotheses describing the mechanism of urban evolution. As far as the methodological hypotheses are concerned, the Lowry model makes three specific assumptions, permitting the general methodological framework provided by input-output to overcome many of the difficulties encountered in its empirical applications:

1) the introduction (in the generation phase, see Fig.1) of a distinction of the urban economy in basic sectors', i.e. those which are responsive to national and international demand and are then externally oriented , and 'service sectors', i.e. those which are responsive to local and urban demand and are internally oriented.
2) the factorisation of the structural coefficients describing the interdipendencies between activities in two multiplicative factors: i) a factor representing the functional linkages and ii) a factor describing the spatial interactions. A unique interdependence matrix can be defined which holds for the whole urban economy. This also provides a fundamental link between the generation and the allocation phase;
3) the formalisation of the spatial interactions by a gravity form (i.e. interactions are directly related to the interacting masses and inversely to the distance between the masses) and the possibility to factorise them as chained interacting fields (i.e. residence $\rightarrow$ services $\rightarrow$ residence $\rightarrow$ ...).

With these hypotheses the Lowry model can be written in matrix form as (McGill, 1976, Rabino and Tadei,1977):

$$\mathbf{x} = (\mathbf{I} - \mathbf{A}bs)^{-1}\,\mathbf{y} \qquad (1)$$

where

x is the column vector of total outputs of the urban sectors (basic and service sectors);

I is the identity matrix;

A is the matrix of the structural coefficients of the urban economy ;

b and s are the chained matrices of the spatial interaction factors

y is the column vector of final demand. (in the basic sectors).

The substantial hypotheses provide the interpretative descriptions which relate the model to the city of the sixties, i.e. the so-called Fordist city. This is essentially viewed as the place of the industrial production, which is labour intensive. The 'basic sectors' of the city, therefore, are the industrial activities which produce goods for the wider national and international markets. The 'services' are all those urban activities which are oriented at the local market (i.e. the resident population of the city). In financial terms the I/O provides the accounting of wages and household expenses (Smith and Morrison, 1977). For the sake of operationality the structural coefficients are expressed in physical quantities, i.e. number of employees, total population, etc.

The constancy of the urban input-output coefficients reflects the intrinsic stability of the economic structure of the city. The evolution of the city is fully driven by the growth of the basic sectors which, on their turn, trigger the growth of the resident population and services.

One last hypothesis concerns the kind of spatial interactions taking place in a Fordist-city. These are mainly flows of employees which travel between the place of work and home and between home and the location of population services (i.e. shops, schools, etc.). and household expenses.

Both the methodological and substantial hypotheses make the Lowry model easy to apply and particularly suited to a specific set of metropolitan areas, i.e. the car-manufacturing towns, such as Turin, Detroit and Pittsburgh. Despite the existence of other city fabrics (i.e. the company towns, gateway cities, etc.) and the transformations which are occurring in Fordist cities, the model has been extensively applied, and until now, the above hypotheses have remained substantially unchanged (apart from some minor modifications, see Lombardo and Rabino, 1984).

Furthermore, the Fordist vision of the city deeply influenced the use of the model for planning purposes. The model was mainly used for exploring the effects of the so-called location impact. Typically, in those simulation exercises an exogenous perturbation of the basic sector (i.e.

the construction of a new industrial plant) is introduced and the resulting variations in the levels of population and services in the urban areas are analysed. Land-uses are generally considered as constraints to the location of activities. Variations in spatial relationships (i.e. the effect of changes in transportation costs) concerned only those physical movements which typically occurred in a Fordist-city, i.e. the journeys-to-works. All the transformations of the city were incremental, consisting mainly of an increase of physical stocks and infrastructure, thus reflecting a vision of urban development as a never-ending economic and spatial growth.

3.2 Towards a Post-Fordist urban model

Although no exhaustive definition of Post-Fordist urban development exists, a generally agreed conviction is that social, economic and institutional processes are at work determining deep functional and spatial changes in most cities of developed countries (see, Amin ed. 1994). Here we would like to emphasise only one aspect of these changes which stands out most prominently.

Compared with a Fordist city, a Post-Fordist city can be defined as a spatial, social and economic system in which the types, characteristics and ways of relationships are increasingly important : not only urban relationships are increased and differentiated (by type, time intensity, frequency, number of actors involved, etc.), but they are also evolutive and self-organising, articulating themselves on different spatial and temporal scales (the global world-wide scale and the local one) and interacting with the relationships of other sub-systems (the environmental and socio-cultural sub-systems, etc.).

If we agree on this broad definition, the most salient feature of the post-Fordist city is the pattern of relationships (i.e. the networking) in itself. In this respect, the input-output still provides a sound methodological framework for analysing the structure of city interdependencies. If in the classical I/O formula (or the Lowry model) we shift the focus from the level of activity (the x and y column vectors) to the matrix of interdependencies, then the Input-Output framework (in the Lowry version) can still be used as a basis for modelling the Post-Fordist city.

For the sake of clarity, it is convenient to refer to the above hypotheses and discuss how they can be relaxed or modified in order to address these new features of the Post-Fordist city. Whereas we can substantially keep unchanged the methodological assumptions, we need to extend the conceptual hypotheses. In particular, attention should be paid at:

1) revising the distinction between basic activities (i.e. those merchant economic sectors driving the whole urban economy) and non-basic activities (i.e. those economic sectors for local demands). A major remark is that the coincidence between basic, propulsive, merchant type and

industrial activity does not hold any more. Industrial activities are not the only basic sectors driving the whole system economy, but as a consequence of globalisation processes all the economic sectors are exposed to the competition of non local markets. As sectoral linkages are increasingly important, the role of economic sectors are influenced to a greater extent by their position within the overall interaction structure (which is endogenously determined by those same linkages, i.e. they can be basic when considered in the regional context but loose their driving role in certain local areas;

2) relaxing the hypothesis of constancy of the urban input-output coefficients. Non-linearities and synergetic effects associated with interdependencies determine endogenous dynamics on the interactions themselves. These aspects have already been extensively explored in the last decade in the domain of the so-called dynamic theoretical urban modelling (for a review, see Crosby, ed.,1983, Bertuglia et al., eds., 1987). In this respect, a crucial problem to be addressed is the transferring of the results of this theoretical modelling domain to the more practical and workable operational modelling field;
3) extending the definition of spatial interactions. Besides considering a wider variety of interactions occurring between urban activities, we also need to take into account that the new information technologies make it possible to substitute many physical interactions by virtual ones (Bertuglia and Occelli, 1995).

3.3 The PF.US model

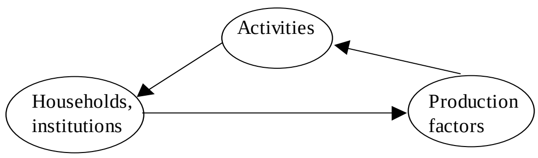
Among the conceptual extensions above mentioned, that relating to the revision of the distinction between basic and non-basic activities is the foremost. As a result, the economic and technological changes now affecting most population oriented services (i.e. the retail activities, Ires, 1996) endow these economic sectors of innovative potentials and widen their market areas. Services, therefore, can play a major role in triggering urban development, thus having (as for the basic sectors in the Lowry model) an exogenous component. Furthermore, functional and spatial interactions of an urban system can have a local-global articulation (Bazzigaluppi, Bramanti and Occelli, eds, 1996). This latter, in particular, implies to recognise that: a) from a substantial point of view, the ‘local’ in whichever way we would define it, is a ‘level at which the transformations of the localised 'resources' (i.e. the housing stock, environmental resources, human capital, etc.).play a role in urban development; b) from a methodological point of view, local and global are two analytic dimensions which are ‘not reducible’ the one to the other (i.e. the properties of the global system cannot be obtained as a sum of the properties of the various local systems, Rosen, 1984, Casti, 1986). The local and global levels do interact permanently, but interactions can be perceived differently according to the point of view (i.e. the level) from which they are observed. Therefore, they provide two distinct ‘windows of observation’ of the urban system.

The main features of the PF.US model are summarised in the following.

a) The urban accounting framework and urban sectors

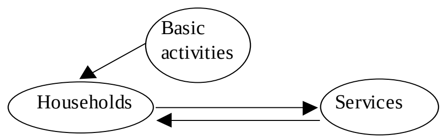
The LUSM (Localised Urban System Matrix) describes the urban accounting framework underlying the PF.US model, see Fig.2c.

		Endogenous factors			*Exogenous*	
		Production factors	Households, institutions	Activities	*factors*	
		1	2	3	4	Total
Production factors	1			M_{13}	M_{14}	Y_1
Households, institutions	2	M_{21}	M_{22}		M_{24}	Y_2
Activities	3		M_{32}	M_{33}	M_{34}	Y_3
Exogenous factors	4	M_{41}	M_{42}	M_{43}		Y_4
Total	5	Y_1	Y_2	Y_3	Y_4	



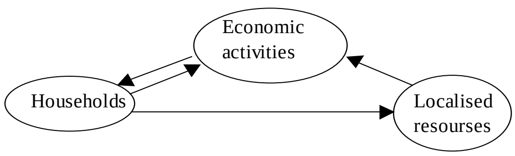
a.Social Accounting Matrix (SAM)(*)

		Endogenous factors			*Exogenous*	
		Services	Househol	Basic activities	*factors*	
		1	2	3	4	Total
Services	1	M_{11}	M_{12}			Y_1
Households	2	M_{21}	M_{22}	M_{23}		Y_2
Basic activities	3			M_{33}	M_{34}	Y_3
Exogenous factors	4	M_{41}	M_{42}	M_{43}		Y_4
Total	5	Y_1	Y_2	Y_3	Y_4	



b.Urban System Matrix (USM)

		Endogenous factors			*Exogenous*	
		Localised resouces	Households	Economic activities	*factors*	
		1	2	3	4	Total
Localised resourses	1	M_{11}		M_{13}		Y_1
Households	2	M_{21}	M_{22}	M_{23}		Y_2
Economic activities	3		M_{32}	M_{33}	M_{34}	Y_3
Exogenous factors	4	M_{41}	M_{42}	M_{43}		Y_4
Total	5	Y_1	Y_2	Y_3	Y_4	



c. Localised Urban System Matrix (LUSM)

Figure 2 Comparison of urban accounting schemes in a SAM, USM and LUSM

In Fig.2 the LUSM is compared with other accounting schemes . (i.e.the Urban System Matrix, of the Lowry model and the Social Accounting Matrix, see Round and Pyatt,1979, Defourny and Thorbecke, 1984). The LUSM consists of the following components: a) economic activities, which include both basic and service activities; b) households (population); c) localised resources which encompass a wide category of environmental, historical, human and architectural resources (see Coccosis and Nijkamp, 1995).

The structure of interactions between these components has two main loops: a)an exogenous injection loop, connecting the external driven economic system to the population system, as in the traditional USM and b)an endogenous activation loop, connecting the socio-economic structure (the economic and population systems) to its spatial context: The localised resources account for a demand share of economic activities which sustain the resident population. The population component, on its turn, sees to maintaining and regenerating the localised resources.

b) Types of relationships and local-global interactions

We can define the 'global level' as the system of urban interdependencies at a regional scale.

The 'local level' corresponds to some sub-regional articulation (i.e. the 'Italian Provinces') from which it is possible to 'describe' the localised resources. In order to take into account this twofold articulation of the urban system, the LUSM shown in Fig.2c, has to be articulated further, as graphically depicted in Fig3.

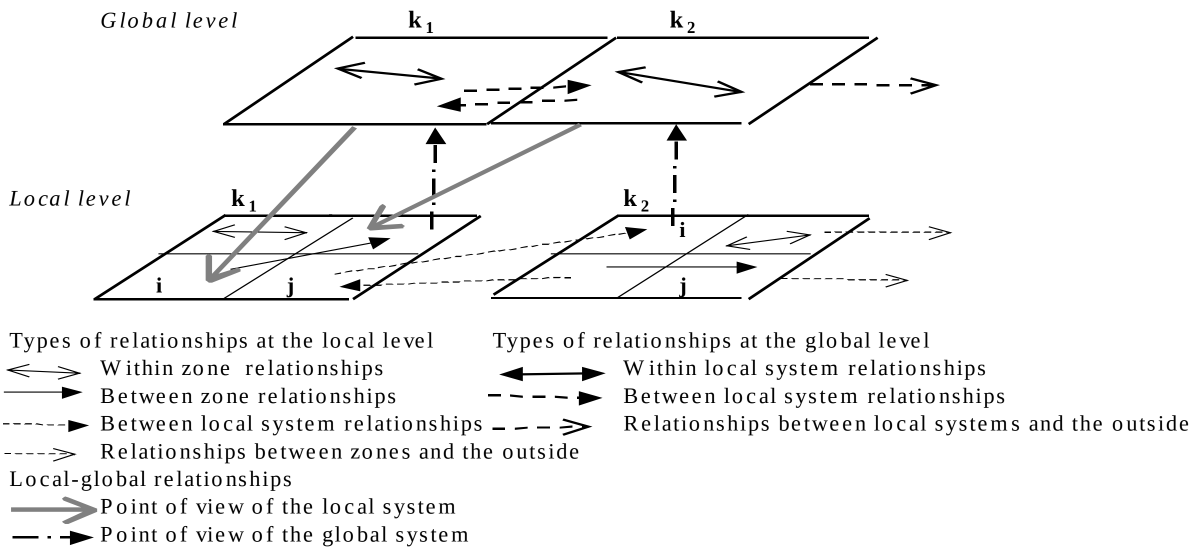


Figure 3 Types of relationships in a LUSM and the local-global interactions

The figure shows: a) the relationships which are relevant at the local and global levels; (i.e. those occurring between the economic activities, population and localised resources) and b) the local-global relationships, which are established at a certain level as a consequence of the perceptions of the systemic properties of the other level. This kind of interactions makes it possible to link the two levels, although in a loosely way. One major implication is that these relationships can act as endogenous injections in the evolution of the urban system..

Whereas interdependencies between activities are described as in a USM (i.e.they are decomposable by additive terms which are articulated in a functional and spatial component) local-global relationships require some additional hypotheses .It is assumed that local-global relationships bring about 'new' kinds of interactions which simply add up to the existing structure of interactions.

c) Categorisation of the activities

The local and global levels of a LUSM entail two distinct 'windows of observation' of the urban system. As a consequence of the intrinsic non-reducibility of the two system descriptions, the perceptions of the urban interdependencies can also be different. The categorisation of activities (i.e. articulation of urban components by classes), therefore, can be different for the two levels. In addition, as each urban system at the local level has specific characteristics which are unique, the categorisation of activities at each level should reflect this specificity.

d) Spatial induction.

As argued previously, a relevant feature of the Post-Fordist city is the pattern of relationships. One major implication is that not only the 'networking' is important but also the 'possibility of interacting' does matter. In this respect, a number of longstanding notions in the urban and regional literature take to the fore : i.e. the concept of potential and accessibility (for a review see Ires, 1994), and the related one of urban field (Angel and Hyman, 1976), the notion of spatial multiplier (Sonis, Hewings, Lee, 1994) and that of externality (Papageorgiou, 1987). All these concepts share two general assumptions: a) because of their location in space human activities influence their surroundings and interact with other localised activities and b) interactions are 'context' dependent, i.e. they are affected by the geographical, spatial, environmental, cultural etc. characteristics of the context within which they take place. The spatial component of the interdependencies between activities, therefore, will take into account the 'effect of spatial induction'

The overall structure of the PF.US model is shown in Fig.4.

4. The application of the PF.US model

The development of the PF.US model takes place within a broader research program which is currently being carried out at Ires on local area analysis and policies. Political and institutional issues (i.e. the recent enforcement of a local government law, the evaluation of EEC Programs) and

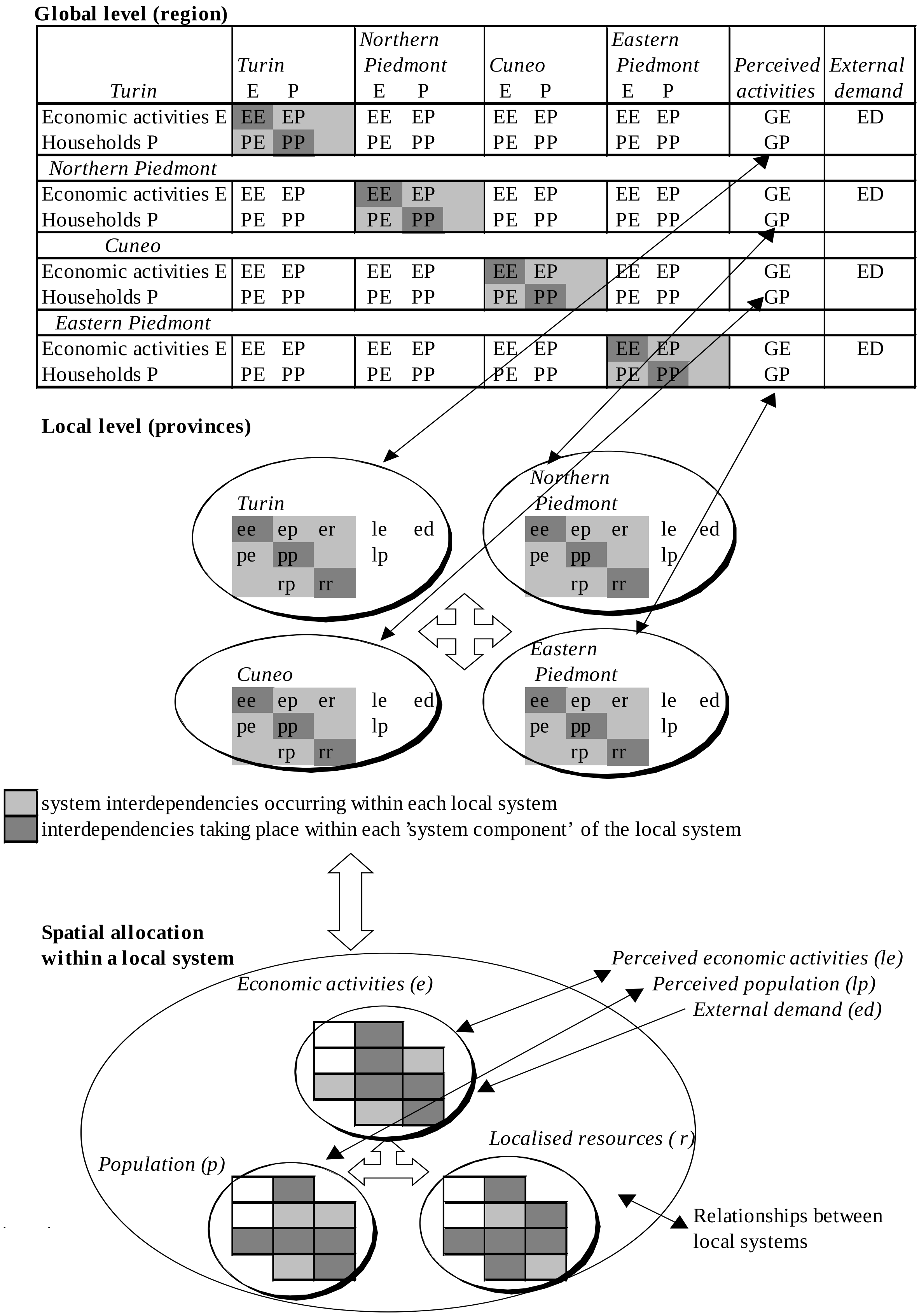


Figure 4 The structure of the PF.US model

the need to provide a support for the planning activity of corporate and regional bodies (i.e. the analysis of the impact of socio-economic scenarios and EEC policies) are major motivations of the Ires research program and modelling activity.

Connected with these motivations is the need to be operational This is at the core of the model conception and justifies many of the simplifications which have been made (i.e. the decision of considering exogenous multipliers and describing the local-global relationships in a relatively simple way). Operationality, however, requires much effort for information gathering, data organization, calibration and validation.It yields several‘by-products’ (i.e. indicators, secondary data, updated information, methodological advancements) which are seldom fully exploited.One major claim in developing the PF.US model is that these 'by-products' are valuable and enhance the 'information gain' of the modelling application.

4.1 Designing the model implementation

a)The study area and its spatial articulation

The study area is the Piedmont region in the North-Western part of Italy. It has about 4,300 thousands inhabitants, 35% of whom live in the Metropolitan Area.Turin, the regional capital, represents 23% of the regional population.

Because of the intended use of the model, the spatial articulation of Piedmont was particular important in this study. According to the local-global distinction of the modelled system, a twofold articulation of the region was defined: a) at the global level the region vas subdivided in four areas: (i.e.the Turin province, the Northern Piedmont, consisting of 4 provinces, the Cuneo province and 4) the Eastern Piedmont, consisting of the two remaining provinces); b) at the local levels, the region was articulated in four local urban systems corresponding to the areas just mentioned, each of which was further subdivided . The zone system consists of 196 zones.

b) The model inputs and calibration

Two major components underlie the definition of the inputs which although conceptually disctint are strictly integrated in the model application. These are:

a) a technical-operational component necessary for defining those inputs making it possible to run the model in a stationary regime, i.e. in a situation where the system description obtained by the outputs is coincident with (approximates) that of the inputs;
b) an ‘explorative' component involved in the specification of a specific sub-set of inputs which are introduced for running the model in a 'non stationary regime', i.e. in a situation in which the model outputs give a system description which is different from that yielded by the inputs.

In the sequel we will mainly focus on the first component, and address the second in a subsequent paragraph.

A major guideline we adopted in building the inputs of the PF.US model is that they should be based on existing and currently available statistical information. In spite of the constraints it posed in defining some variables (i.e. data categorization), this put a claim on the possibility to turn into better account existing information, i.e. providing a bridge between information of different statistical sources (i.e. Population and Economic Activity Censuses, socioeconomic data and financial regional accountings). Notwithstanding the results of this study give suports to those arguments of ‘systemic descriptions’ underlying well-known notions of ‘spatial accounting’ (Masser, 1983) and ‘performance indicators, (Clarke and Wilson, 1987a, 1987b, Bertuglia, Clarke and Wilson, eds., 1994), they also indicate that the availability of spatial data is still rather poor.

A second point to be emphasized is that the effort involved in the definition of certain inputs can open new research directions. In the present study, for example, the need to define the types of activity in the various local systems and determine travel times between zones required additional work, which resulted in parallel researches. The former stimulated a study of measurement indicators for spatial heterogeneity which will also be useful for the analysis of model output (see, Occelli, Novelli, 1998). The latter resulted in the development of a package with a GIS interface which calculates the travel ‘costs’ between a set of nodes, given certain characteristics of the links connecting them

A last but not least point relates to the calibration of the model. It consists of: a) the calibration of the spatial components of the interdipendence coefficients (i.e. to define the spatial induction terms), for each area at the local level; b) the ‘tuning’ of the local-global interactions. For the sake of the discussion only the former will be discussed here. In the model package, the calibration of the spatial components is performed by a specific module that can be run autonomously. Both the calibration and the simulation modules are written in C++ and operate in PCs' Windows domain. In the calibrabion module a standard procedure for a double constrained spatial interaction model has been implemented (Batty, 1976). This is applied for each activity component in each local system. Yielding information about the spatial profiles of urban activities in each local system, the results of calibration deepen our insights of the spatial pattern of activities at the sub-regional level, Tab.1:

In particular, they indicate that

1. as expected, the spatial distribution of core activities and firm services are more concentrated than that of population services and other economic activities. The highest value of the

parameter for the localised resources provide supports to the common view that their specificity tend to result in more selective spatial patterns;

Table 1 Values of the impedance parameter for the activity components in each local system

	Turin	Northern Piedmont	Cuneo	Eastern Piedmont
Core activities	0.195	0.208	0.161	0.169
Firm services	0.177	0.192	0.177	0.172
Population services	0.174	0.188	0.172	0.168
Other activities	0.178	0.184	0.164	0.159
Population	0.175	0.181	0.160	0.175
Lolcalised resources	0.195	0.213	0.184	0.168

2. as far as the local areas are concerned, the higher values of the impedance parameters for Turin and Northern Piedmont, compared with those of Cuneo and Eastern Piedmont, reflect well known long standing socio-economic differences existing between an 'industrial' North, and an 'agricultural' South.

4.2 Towards a Post-Fordist use of an operational urban model

As already pointed out, the 'explorative component' involved in the definition of inputs has a crucial role in the use of the model. Actually, this is one major aspect differentiating a PF.US kind of model from earlier operational urban models. The most outstanding feature is associated with an extension of the notion of simulation as a result of the increased relevance of the 'cognitive' use of the model in many practical applications (see, Pidd, 1996, Conte, Hegselmann and Terna eds., 1997).

Whereas in earlier model applications the notion of simulation was mainly associated with the algorithmic features of modelling, i.e. it was a procedure specially devised to find a solution to complex or dynamic equations, nowadays it has a stronger conceptual emphasis. Furthermore, not only simulation is a way to explore the impact of an action or an event on a certain system, but it is also a very efficient way for reasoning about the 'action' itself, likely alternative actions and their viability. 'Reasoning' is thus the major aim of the simulation exercise. In other words, a shift is occurring in the implementation of the '*what if*' statement. Whereas in the earlier simulation models the '*what*' was the main focus of attention , now the '*if*' becomes the major topic of interest. The possibility to explore alternative courses of action, adjust them and assess their viability are crucial elements in the simulation exercises. As already argued in the first sections, therefore, because of simulations, model application is an essential way for enhancing our capacity to address urban problems.

These arguments have several implications in the use the PF.US model. First of all, attention will have to be shifted from the analysis of the impact of the 'external demand' to the analysis of the 'viability' of the redistribution process made possible by the urban interdependencies. 'Reasoning' is then required in defining socio-economic scenarios which are consistent with the model descriptions and the external actions (i.e. policy measures). Finally, there will be a need to ientify a set of relevant criteria making it possible to compare the simulation results and assess the simulated socio-economic scenarios.

5.Concluding remarks

This paper presented an urban model which may constitute a prototype of a new generation of operational urban models. The consideration of the 'localised resources' as a main component in the urban structure and the local-global articulation of the system interdependencies are major elements of novelty of the model. Although we mainly focussed on the conceptual underpinnings, some operational features of the model were also discussed. They emphasised a fundamental claim of this study which attributes a major importance to a 'cognitive use 'of the model. Associated with the modelling application,in fact, are a number of benefits which are still largely unexploited:

- the development of an analytic tool, user-friendly and easy to apply, to be used for explorative analysis and policy evaluation.;
- the creation of a coherent data base of relevant information concerning urban system at a spatially disaggregate scale;
- 'innovative thinking' about the possibilities enabled by the introduction of a set of alternative 'policy actions';
- the suggestion of guidelines for carrying out more focussed surveys aimed at filling existing information gaps.

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